

ECOLOGY OF A NESTING RED-SHOULDERED HAWK POPULATION

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AN ECOLOGICAL study of the Northern Red-shouldered Hawk (*Buteo lineatus lineatus*) was made on the Coastal Plain of Maryland in Prince Georges and Anne Arundel Counties during the spring of 1947. The objective was to gain information on habitat requirements, population densities, reproductive rate, food habits, and other factors relating to the nesting, survival, and environmental relationships of this species.

Field data accumulated during this investigation form the basis for most of the information in the present paper. However, supplemental data from observations on the Patuxent Refuge during the preceding 4 years are also included. In the field work during 1947 the author was assisted by R. Bruce Overington and Alvis K. Melton. James B. Cope helped with the studies on the Refuge during the preceding years. Grateful acknowledgment is also made to William H. Stickel who identified fragments of mammals, reptiles, and amphibians found in several pellets taken from the Red-shouldered Hawk nests.

The 1947 study area (Fig. 1) comprising about 185 square miles, included almost the entire watershed of the Patuxent River from the fall line (natural boundary between Piedmont and Coastal Plain) down the river valley to a point near the upper limits of tidewater.

In this region the conspicuous courtship maneuvers of the Red-shouldered Hawk generally first become noticeable during the last week in February and continue through March and the first half of April. Nests are completed during the earlier part of this period and the eggs are usually laid between March 20 and April 10. In most cases, the hatching period occurs during the last 10 days in April and first 10 days in May. The young birds leave the nest sometime during the first 3 weeks of June.

HABITAT REQUIREMENTS

On the Coastal Plain of Maryland a combination of fairly extensive flood-plain forests with adjacent clearings appears to meet the major ecological requirements of the Red-shouldered Hawk during the nesting season. Within the study area this habitat combination was found to occur only along the Patuxent River and a few of its larger tributaries. These hawks were almost entirely absent in upland forested areas or in clearings that were situated more than .25 mile from flood-plain forests.

The flood-plain forests differ considerably from most of the upland forests in this region (Hotchkiss and Stewart, 1947). The overstory of the flood-plain



FIG. 1—Map of 1947 Study Area Showing Distribution of Pairs of Nesting Red-shouldered Hawks. The solid circles show the nest locations, while the open circles represent the approximate centers of territories of pairs whose nests were not found. The dashed lines represent the approximate boundaries of the areas that were inhabited by Red-shouldered Hawks, and the outer heavy line represents the boundary of the study area.

forests consists of a considerable variety of deciduous trees, the more important of which are: Sweetgum (*Liquidambar styraciflua*), River Birch (*Betula nigra*), Pin Oak (*Quercus palustris*), Red Maple (*Acer rubrum*), Tulip-tree (*Liriodendron tulipifera*), Beech (*Fagus grandifolia*) and Hornbeam (*Carpinus caroliniana*). Most of the upland deciduous forests are dominated by various species of oak (*Quercus* spp.), although locally, hickories (*Carya* spp.) and Tulip-tree are common. Virginia Pine (*Pinus virginiana*) and Pitch Pine (*Pinus rigida*) are often prevalent on upland areas that have been retired from agriculture.

In general, the Red-shouldered Hawk, throughout its range, occurs in moist, well-drained woodlands or in wooded river swamps during the nesting season. In the New York City region it prefers "richer lowlands where damp woods border on fields and marshes" (Cruickshank, 1942). It is usually far more common in lowland areas than in mountainous regions and prefers the borders of streams, lakes or swampy woods. In Massachusetts this species occurs regularly in the hardwood region of the southeastern part of the State as well as in the White Pine region to the north; and in Florida, the Florida Red-shouldered Hawk (*Buteo lineatus alleni*) "seems to be equally at home in extensive flat pine woods and in the dense live-oak hammocks" (Bent, 1937). In California, the California Red-shouldered Hawk (*Buteo lineatus elegans*) "is essentially a bird of the lower wooded river bottoms between sea level and 1200 feet" (Dixon, 1928) although Sharp (1906) found that it also showed a fondness for Eucalyptus groves.

POPULATION DENSITY

A census of nesting Red-shouldered Hawks in the 1947 study area (185 square miles) was conducted by attempting to locate the nest of each pair in the area, or failing that, to determine the boundaries of its nesting territory. The search for nests was carried out in late March and April before most of the leaves on the deciduous trees had appeared. A large proportion of the study area is open farmland which was covered quickly and satisfactorily by using an automobile. All wooded areas of any size were covered carefully on foot and many were revisited several times—especially when the terrain and vegetation appeared suitable for Red-shouldered Hawk habitation. Nest records and other observations pertaining to population densities and ecology of this species were plotted on War Department Quadrangle Maps (7½-minute series) that covered the area being studied.

A total of 51 pairs were located within the area and for 43 pairs, occupied nests were found. These 51 pairs ranged over approximately 42 square miles of territory or about 23% of the entire study area (185 square miles). The thoroughness of the coverage of the study area together with the fact that this species is quite conspicuous during the early part of its nesting season, makes it seem unlikely that any pairs were missed.

The population density for the part of the area (42 square miles) occupied by this species was about one pair per .8 of a square mile, while the density for the entire 185 square miles included in the study area would be 1 pair per 3.6 square miles. On an average the territory of each pair included about 160 acres of flood-plain forest which represented one-third of the total area included in the territory.

By referring to the map of the study area (Fig. 1), it may be seen that the nests or territorial centers were distributed fairly regularly over most of the flood-plain forests. This regularity in spacing is especially well marked in areas where the width of the flood-plain is relatively constant. In one such area the average intervening distance between 8 adjacent nests was .56 mile, while the maximum distance was .65 mile and the minimum .45 mile. The minimum distance in this case also represents the shortest distance between any 2 occupied nests in the entire study area.

TABLE 1
Distance Between Nests as Related to Width of Flood Plain

FLOOD PLAIN	MEAN WIDTH (IN MILES) OF FLOOD PLAIN (BASED ON MEAS- UREMENTS TAKEN AT ½ MILE INTERVALS)	DISTANCE BETWEEN NESTS (OR TERRITORIAL CENTERS) IN ADJOINING TERRITORIES		NUMBER OF NESTS (OR TERRITORIAL CENTERS)
		Mean distance (in miles)	Standard deviation	
Patuxent River (Upper two-thirds) . . . . .	.48	.67	.22	22
Patuxent River (Lower one-third) . . . . .	.28	.88	.19	8
Little Patuxent River . . . . .	.20	.98	.24	10
Western Branch . . . . .	.12	1.34	.24	6

In general, the distances between nests of adjacent pairs were found to vary inversely with the average width of the flood-plain (table 1). The 8 adjacent nests mentioned above, which averaged .56 mile apart, were located along one section of the Patuxent River where the average width of the flood plain was .53 mile. Along one fairly uniform stretch of the Little Patuxent River the average width of the flood plain was approximately .16 mile and here the intervening distances between 8 adjacent nests averaged about .96 mile.

A noticeable break in the distribution of nests or territories occurred along the lower course of the Little Patuxent River. Here the habitat conditions appeared to be entirely suitable and several old nests were found, although not a single Red-shouldered Hawk was seen or heard. Since this locality is popular for its hunting and fishing it is quite possible that the resident hawks had been shot out.

Bent (1937) found this species to be much more common in Florida than elsewhere. Along the Kissimmee River, 65 nests were found in an area 10 miles long by 5 miles wide, in a single season. On the basis of the nests found, the

population density for this area (about one pair per .8 of a square mile) is practically identical to the density found in the 42 square miles inhabited by this species in the Maryland study area. It appears that this figure would approximate the minimum breeding density of the Red-shouldered Hawk where it occurs under optimum environmental conditions.

Apparently the breeding population density of this species is generally somewhat greater in the southern States than it is in other parts of its range. Along the Nueces River in Texas, Hahn (1927) reported that nests were usually from .25 to .50 mile apart. In one clump of trees about .50 mile square he found 5 nests. In southern Florida, Nicholson (1930) found that 2 pairs rarely used the same hammock, although on 2 occasions he found nests a few hundred yards apart. In the Buckeye Lake Region, Ohio, during the period 1922-24, Trautman (1940) found that the Red-shouldered Hawk population averaged slightly more than 22 pairs per year on an area that covered a little less than 44 square miles (1 pair per 2 square miles). In California, Dixon (1928) had a record of 23 nesting locations within a radius of 30 miles of Escondido, which he believed was all that the food supply of the area would warrant. Since the population density of this species is closely correlated with habitat conditions, its probable greater abundance in the southern States may be due to the extensive swamp forests that occur so commonly there. Elsewhere the required habitats of this species are more local and restricted in size.

NEST SITES

All of the nests found during this investigation were located in forested stream valleys. Fifty-one nests were on the flood plain while six nests were found on fairly steep river bluffs. Most of the nests were built in rather large trees. The D.B.H. measurements of the nest trees ranged from 1-4 feet and averaged about 2 feet. The height of the nests above the ground varied considerably, the lowest being 28 feet, the highest 77 feet, and the average about 50 feet. Roughly 90 percent of the nests were built in crotches of the main trunks, the remainder being situated in crotches of branches off the main trunks. One nest was suspended between limbs about one foot above an upright crotch, while another had been constructed on top of an old squirrel nest. Almost half of the nest trees had a fairly dense growth of Poison Ivy (*Toxicodendron radicans*) clinging to them. The nests were situated in a considerable variety of deciduous trees. These are listed as follows:

- River Birch (*Betula nigra*)—13 nests
- Pin Oak (*Quercus palustris*)—9 nests
- Beech (*Fagus grandifolia*)—8 nests
- Sycamore (*Platanus occidentalis*)—5 nests
- Tulip-tree (*Liriodendron tulipifera*)—4 nests
- Red Ash (*Fraxinus pennsylvanica*)—3 nests
- Sweetgum (*Liquidambar styraciflua*)—3 nests

Red Maple (<i>Acer rubrum</i>)—3 nests
White Oak (<i>Quercus alba</i>)—3 nests
White Ash (<i>Fraxinus americana</i>)—2 nests
Willow Oak (<i>Quercus phellos</i>)—1 nest
Southern Red Oak (<i>Quercus falcata</i>)—1 nest
Black Oak (<i>Quercus velutina</i>)—1 nest
Swamp Chestnut Oak (<i>Quercus prinus</i>)—1 nest

Some preference may be indicated for certain species in this list. Although the first three, River Birch, Pin Oak, and Beech are among the more common species in the flood-plain forest, Sweetgum and Red Maple are equally as common and yet lag well behind in the number of nests that were situated in them. The reasons for such preferences, if they do exist, were not apparent.

Nests of the Red-shouldered Hawk have been found in a considerable variety of deciduous trees throughout its range (Bendire, 1892; Bent, 1937; Dixon, 1928; Trautman, 1940). In the northeastern states they also occur commonly in pine and occasionally in Hemlock, while in the southeastern and gulf states they have been found in pine, cypress, Cabbage Palmettos, Black Mangrove, and various species of broad-leaved evergreen trees (Bent, 1937; Kennard, 1894; Todd, 1940). In California the nests are frequently built in Eucalyptus trees as well as in the bottomland hardwoods, while in Lower California they have even been found in giant cactus and candlewood (Bendire, 1892; Dixon, 1928; Sharp, 1906). In general, the height of the nests above the ground in different parts of its range appear to be similar to those found in the Maryland area, except that nests in the extreme southern part of the range (southern Florida and Lower California) appear to average somewhat lower than those to the north. This may be a reflection of an average lower height of suitable trees in these southern areas. The lowest measurements were 2 nests 10 feet above the ground, 1 in a buttonwood in southern Florida (Bent, 1937) and 1 in a sumac bush in Lower California (Bendire, 1892), while the highest was 1 nest 85 feet above the ground, situated in a Sycamore in California (Dixon, 1928).

ASSOCIATION AND COMPETITION WITH OTHER RAPTORES

The absence of Red-shouldered Hawks along Collington Branch (Fig. 1) might have been due to the presence there of 2 nesting pairs of the Eastern Red-tailed Hawk (*Buteo jamaicensis borealis*). A few scattered pairs of Red-tailed Hawks were found throughout the study area, although most of them occurred on the upland away from the stream bottoms, so that ordinarily there was probably very little competition between the two species. The habitat requirements of the Northern Barred Owl (*Strix varia varia*) and the Red-shouldered Hawk must be very similar since they were commonly found associated together in the same areas. However, no evidence of any antagonism between them was noted. On the Patuxent Research Refuge in 1943, a Red-shouldered Hawk nest was found only 160 feet from an occupied Barred Owl nest. Other nesting

raptors which occurred in the study area, including the Great Horned Owl (*Bubo virginianus virginianus*), Cooper's Hawk (*Accipiter cooperi*), Broad-winged Hawk (*Buteo platypterus platypterus*), and Eastern Sparrow Hawk (*Falco sparverius sparverius*), were all largely restricted to habitats on the upland, and therefore had little opportunity to compete with the Red-shouldered Hawk.

In Massachusetts, Bent (1937) found the Red-shouldered Hawk and Barred Owl to be "tolerant, complementary species, frequenting similar haunts and living on similar food, one hunting the territory by day and the other by night." On the other hand, he noticed that the Red-tailed Hawk and Red-shouldered Hawk seemed to represent competitive and antagonistic species which apparently never nest near each other.

TABLE 2
Contents of Red-shouldered Hawk Nests

YOUNG	NESTS
4	10
3	17
2	16 (two of which also contained single sterile eggs)
1	4 (one also containing 2 sterile eggs and another one sterile egg)
?	2 (contained young but not examined closely)
deserted	3
127+	52

REPRODUCTIVE RATE

Most of the nests were found during the nest-building, egg-laying, or incubation periods and were not examined closely until after the young had hatched. At the time of climbing to the nests, nearly all of the young had completed half or more of their growth. Out of 52 nests (table 2) which were revisited at this stage, only 3 (6 percent) were found to be deserted. The number of young in the nests which were still occupied ranged from 1-4 and averaged 2.7. Four of the nests with young also contained sterile eggs, 3 nests being found with single eggs and 1 nest with 2 eggs.

Very little could be found in the literature on the number of young Red-shouldered Hawks in nests following hatching, although there is considerable information on the number of eggs that are laid. In the northeastern and north-central states (Bent, 1937; Todd, 1940; Trautman, 1940) 3-4 eggs are usually laid, with 3 being more common than 4. Two eggs are occasionally laid and very rarely sets of 1 or 5 eggs may be found. Bendire (1892) even records 2 sets of 6. In Texas and California (Bent, 1937; Dixon, 1928; Hahn, 1927; Sharp, 1906) 3 eggs are generally laid although sets of 2 are fairly common and occasionally sets of 4 are found. In Florida (Bent, 1937; Nicholson, 1930), the usual number of eggs is 2, although 3 are occasionally found and very rarely 4. These data bear out

the conclusions of Lack (1947), that many species tend to lay more eggs in the northern than in the southern part of their range. In this respect, the Red-shouldered Hawks in Maryland are similar to those in California and Texas, being intermediate between the birds of Florida on the one hand and the birds of the north-central and northeastern states on the other.

FOOD HABITS OF NESTLINGS

During the course of this study, a total of 43 food items of about 23 different kinds were taken from 17 nests. These were in the form of freshly killed prey, as older fragments in the nest debris, or as parts of regurgitated pellets. On the basis of occurrence of these food items, reptiles comprise 37 percent (16 items) of the food, mammals 33 percent (14 items), birds 19 percent (8 items), amphibians 9 percent (4 items), and insects 2 percent (1 item). A more detailed breakdown of these foods follows:

Food of Nestling Red-shouldered Hawks

(Percentages Based on Occurrence of Food Items)

Mice, Moles, and Shrews.....	23%
4 Field Mice (<i>Microtus pennsylvanicus</i>)	
2 unidentified mice (Microtinae)	
2 Star-nosed Moles (<i>Condylura cristata</i>)	
1 Common Mole (<i>Scalopus aquaticus</i>)	
1 Short-tailed Shrew (<i>Blarina brevicauda</i>)	
Snakes.....	19%
6 unidentified snakes (3 Colubridae, 3 Natricinae)	
1 Water Snake (<i>Natrix</i> sp.)	
1 Ground Snake (<i>Haldea valeriae</i>)	
Small Birds.....	14%
3 unidentified birds	
2 Indigo Buntings (<i>Passerina cyanea</i>)	
1 warbler nest stained with blood	
Lizards.....	14%
3 Race Runners (<i>Cnemidophorus sexlineatus</i>)	
1 Blue-tailed Skink (<i>Eumeces fasciatus</i>)	
1 unidentified Skink (<i>Eumeces</i> sp.)	
1 unidentified lizard (Scincidae)	
Rabbit.....	9%
4 Cottontail Rabbits (<i>Sylvilagus floridanus</i>)	
Frogs and Toads.....	9%
2 American Toads (<i>Bufo americanus</i>)	
1 Wood Frog (<i>Rana sylvatica</i>)	
1 unidentified frog	
Game Birds.....	5%
1 Mourning Dove (<i>Zenaidura macroura</i>)	
1 Bob-white (<i>Colinus virginianus</i>)	
Small Snapping Turtles.....	5%
2 Snapping Turtles (<i>Chelydra serpentina</i>)	
Beetles.....	2%
1 unidentified beetle (Coleoptera)	

Detailed observations of food habits of Red-shouldered Hawk nestlings at 16 nests in New York State (Ernst, 1945) were analyzed as follows: mice and rats (principally *Microtus*)—58%; amphibians (principally Leopard Frogs and sala-

manders)—18%; insects (mostly grasshoppers, beetles, and caterpillars)—10%; small birds—8%; reptiles—3%; and miscellaneous items—3%. One young domestic duckling brought to a nest was the only authentic case of poultry being taken in 4 years. In western Pennsylvania (Todd, 1940) "the young are fed on mice and other small mammals, frogs, crayfish, insects, snakes, and occasionally small birds." In South Carolina, Wayne (1910) writes that "during the breeding season this hawk frequently catches chickens and even grown fowls, but its principal food is mice, frogs, and snakes."

Besides the records just mentioned, scattered observations of the food habits of nestling Red-shouldered Hawks have been recorded in Massachusetts (Bent, 1937; Hersey, 1923; Kennard, 1894), California (Dixon, 1928; Sharp, 1906), Texas (Hahn, 1927), Wisconsin (Errington, 1933), and New York (Chapin, 1908). On the basis of the occurrence of 52 items thus recorded, mice, rats, shrews, and moles comprise 27% of the food, small birds 17%, frogs 15%, snakes 14%, gallinaceous birds (including poultry) 8%, rabbits and squirrels 6%, and miscellaneous items 13%.

All of these observations, including the records obtained in the present study, help to illustrate the diversified diet of these young carnivorous birds.

SUMMARY

An ecological study of a nesting Red-shouldered Hawk population was made over a 185 square mile area on the Coastal Plain of Maryland in 1947. The courting and nesting season extended from late February until late June.

During the nesting season a combination of fairly extensive flood-plain forest with adjacent clearings appears to meet the major ecological requirements of the Red-shouldered Hawk in this region. A total of 51 pairs was found in the study area, occupying about 42 square miles or 23% of the total area studied. The population density on the land that was suitable for this species was about 1 pair per .8 of a square mile, while the density for the entire study area would be only about 1 pair per 3.6 square miles.

Nests were spaced fairly evenly over most of the flood-plain forests, especially in areas where the width of the flood plain was relatively constant. There was an inverse correlation between the width of the flood plain and the distances between nests in adjacent territories. The nests were all situated in fairly large trees and were from 28 feet to 77 feet above the ground, averaging 50. They were found in 14 different species of trees, all deciduous.

The Barred Owl and Red-shouldered Hawk were commonly associated together in the same lowland habitats. Other raptors were all largely restricted to upland habitats.

The average number of young in 47 occupied nests following the hatching period was 2.7 with extremes of 1 and 4. Only 3 out of 52 nests (6%) were found deserted at this time.

The food habits of nestling Red-shouldered Hawks are very diversified. They feed on many types of warm-blooded and cold-blooded vertebrates as well as invertebrates.

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